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AD-A205 242

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REPORT DOCUMENTATION PAGE

1b. RESTRICTIVE MARKINGS

2b. DECLASSIFICATION / DOWNGRADING SCHEDULE

3. DISTRIBUTION / AVAILABILITY OF REPORT
Approved for public release; distribution unlimited.

4. PERFORMING ORGANIZATION REPORT NUMBER(S)

5. MONITORING ORGANIZATION REPORT NUMBER(S)
ARO 20282.2-EL-F

6a. NAME OF PERFORMING ORGANIZATION
Univ. of California

6b. OFFICE SYMBOL *(If applicable)*

7a. NAME OF MONITORING ORGANIZATION
U. S. Army Research Office

6c. ADDRESS *(City, State, and ZIP Code)*
Los Angeles, California 90024-1594

7b. ADDRESS *(City, State, and ZIP Code)*
P. O. Box 12211
Research Triangle Park, NC 27709-2211

8a. NAME OF FUNDING / SPONSORING ORGANIZATION
U. S. Army Research Office

8b. OFFICE SYMBOL *(If applicable)*

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
DAAG29-83-G-0013

8c. ADDRESS *(City, State, and ZIP Code)*
P. O. Box 12211
Research Triangle Park, NC 27709-2211

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*
Infinite Phased Array of Microstrip Dipoles in Two Layers

12. PERSONAL AUTHOR(S)
Jesus Alfonso Castaneda

13a. TYPE OF REPORT Final
13b. TIME COVERED FROM 3/1/83 TO 1/3/87
14. DATE OF REPORT *(Year, Month, Day)* January 1989
15. PAGE COUNT 3

16. SUPPLEMENTARY NOTATION The view, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

17. COSATI CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
Microstrip Dipoles, Dipole Array, Greens Function
Microstrip Array

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

A method has been devised for the analysis of the infinite printed strip dipole array in a two layer microstrip substrate structure. The complete dynamic Green's function appropriate to the two-layer substrate-superstrate structure was used in the formulation of the method of moments

(continued on back)

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT
☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION
Unclassified

22a. NAME OF RESPONSIBLE INDIVIDUAL

22b. TELEPHONE *(Include Area Code)*

22c. OFFICE SYMBOL

ARO 20282.2-EL-F

FINAL REPORT

ON

U.S. Army Research Office
Graduate Fellowship, Grant No. DAAG 29-83-G-0013

TITLE: "Infinite Phased Array of Microstrip Dipoles in Two Layers"

Ph.D. Dissertation
Electrical Engineering Department
University of California
Los Angeles, CA 90024

January, 1989

89 2 15 054

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Statement of the Problem

A full wave analysis is presented for an infinite phased array of microstrip dipoles embedded within a two layer substrate structure (substrate-superstrate). The materials can be dielectric or magnetic, and may be lossy. The array elements considered include the gap excited strip dipole and the electromagnetically coupled strip dipole.

The Moment Method solution to the electric field integral equation (Pocklington's) provides the resultant currents on the strips, from which the active input impedance of the element in the infinite phased array environment is found. The emphasis is on the characterization of input impedance as a function of phase scan angle. Results for several substrate-superstrate structures illustrate the utility of the single and multi-layer substrate for the enhancement of sx performance. Single plane scanning arrays, volumetric scanning arrays, and the elimination of scan-blindness are discussed.

Waveguide simulator measurements involving a two layer substrate were used for verification of the method. The agreement between experiment and theory over a significant frequency band is good.

Summary of Most Important Results

A method has been presented for the analysis of the infinite printed strip dipole array in a two layer microstrip substrate structure. The complete dynamic Green's function appropriate to the two-layer substrate-superstrate structure was used in the formulation of the method of moments solution. In this way all the substrate effects, including the surface wave related phenomena, have been included in the development and solution. The solution provides a means by which the most important performance characteristics of the finite-but-large phase-scanned microstrip array can be studied. Attention has been focused on the characterization of the active input impedance as a function of the equivalent scan angle.

It is seen that with the proper choice of the substrate and superstrate material parameters (thicknesses, permittivities, and permeabilities) it is possible to obtain exceptionally good wide-angle-impedance-match characteristics. This was demonstrated numerically for both single-plane and two-plane scanning arrays.

The computed results which were referred to above support the usefulness of the two layer microstrip antenna array structure. The validity of the theory and computations has been established by comparison to measurements on a waveguide simulator. The computed and measured data compared well. The waveguide simulator modeled the infinite array of strip dipole elements in an electrically thick two-layer substrate. The element spacing was electrically small. An electrically thick substrate and an electrically small element spacing are the conditions that give rise to the strongest mutual coupling thru both space waves and surface waves. Thus, as configured, the experiment involves both of these phenomena. The conclusion is that the theory and the computations as developed can be used with confidence to characterize the active input impedance of a microstrip dipole array on a two layer substrate. Moreover, it has been shown that the two layer structure can be used to great advantage in the improvement of scanning performance.

Computation were also made for cases that involve a scan blindness condition. In the two layer structure it is possible to select the parameters such as to prevent the excitation of any surface waves. When applied to the design of an infinite microstrip array, those conditions also lead to the elimination or avoidance of scan blindness.

Publications

J. Castaneda and N. G. Alexopoulos, "Infinite Arrays of Microstrip Dipoles with a Superstrate (Cover) Layer," IEEE International Symposium on Antennas and Propagation Digest, pp. 713-716, Vol. II, June 17-21, 1985, Vancouver, Canada.

Personnel

U.S. Army Research Office Graduate Fellowship, Grant No. DAAG 29-83-G-0013, J. A. Castaneda; Ph.D. degree earned December, 1988.